NERL Research Abstract

EPA's National Exposure Research Laboratory
GPRA Goal 4 - Safe Communities
APM # 231

Significant Research Findings

Advanced Pesticide Risk Assessment Technology

Purpose

Prospective modeling is an important tool for assessing the environmental safety of new pesticidal active ingredients, new uses for currently registered products, and for evaluating the implications of new findings in their product chemistry and fate behaviors. Climate, soil properties, limnology, and agronomic practices influence exposure by controlling the movement of pesticides within the agricultural landscape and by governing the speed and products of transformation reactions. These factors vary with time and with location within the (often) continent-wide use patterns of agricultural chemicals. This, together with measurement uncertainty as to the values of chemical properties, demands a statistical and probabilistic approach to risk assessment.

Research Approach

Pesticide dynamics and exposures depend upon specific properties of the atmosphere, agro-ecosystems, receiving waters, and resident biota. Thus, an effective pesticide modeling technology must contain validated algorithms for transport and transformation of pesticides, extensive databases of agro-ecosystem scenarios (crop and soil properties, meteorology, limnology, fish community ecology), and graphical user interfaces to maximize the ease of production and interpretation of complex, highly detailed probabilistic analyses. Several Agencies collect data of significance for environmental safety, but these data must be assembled in usable forms, organized by appropriate landscape units, and made accessible to simulation models if their potential is to be realized.

Major Findings and Significance

Four simulation models have been selected as the core of this project: AgDRIFT, a model of the aerial loss of pesticides during application; the Pesticide Root Zone Model (PRZM), whose subject matter is pesticide dynamics on the land surface; the Exposure Analysis Modeling System (EXAMS) for transport and transformation of pesticides in aquatic ecosystems; and the Bioaccumulation and Aquatic System Simulator for fish community dynamics responses to toxic stress (BASS/FGETS). A Geographic Information

System (GIS) coverage of the continental U.S. has been created using state parts of Major Land Resource Areas as the fundamental unit of analysis. Linked meteorological datasets of 50+ years duration are being assembled and conformed for use by all the simulation models to assure consistency and uniform quality of input parameters. Within the analytical units, analysis of the Census of Agriculture and the National Resource Inventory is yielding data as to the actual soils and biogeography of North American crops to increase the realism of Agency modeling studies. New User's Guides are being released for PRZM (Version 3.12), EXAMS (Version 3.0), and BASS (beta test version 2.1). The release of EXAMS with this APM incorporates significant new technology in its ability to function within a watershed context by accepting automated inputs from AgDRIFT and PRZM, and by producing exposure files for use by the BASS model. EXAMS' algorithms have also undergone significant upgrades in its ability to develop, *inter alia*, underwater (photochemical) light fields from fundamental earth system data and air-water transport fields from meteorological data; EXAMS' documentation now includes revised discussions of the underlying science and pedagogical materials for user training. Completed GUIs for ADRIFT and BASS are available, and a preliminary GUI for combined PRZM/EXAMS simulation studies using current OPP procedures is in preparation for early release.

Research Collaboration and Publications

The Advanced Pesticide Risk Assessment Technology is designed and conducted by a research team at the National Exposure Research Laboratory's Ecosystems Research Division in Athens, GA, headed by Principal Investigator Lawrence A. Burns. Examples of recent publications from this study follow.

Barber, M.C. Bioaccumulation and Aquatic System Simulator (BASS). User's Manual for Beta Test Version 2.1 (In review).

Barber, M.C. A comparison of models for predicting chemical bioconcentration in fish. *Canadian Journal of Fisheries and Aquatic Sciences*. In preparation.

Bird, S.L., Perry, S.G., Ray, S.L., Teske, M.E. Evaluation of the AgDrift aerial spray drift model. *Environmental Toxicology and Chemistry*. Submitted.

Burns, L.A. Exposure Analysis Modeling System (EXAMS): User manual and system documentation (APM 231; 09/2000). 2000.

Teske, M.E., Bird, S.L., Esterly, D.M., Curbishley, T.B., Ray, S.L., Perry, S.G. AgDRIFT: A model for estimating near-field spray drift from aerial applications. *Environmental Toxicology and Chemistry*. Submitted.

Future Research

The Advanced Pesticide Risk Assessment Technology project began in 1999 and will conclude in 2008 with the release of studies serving as examples of the deployed technology and as validations of the underlying algorithms, data sets, and statistical evaluation methods. Modernization of the individual computer codes to take advantage of Fortran95's advanced memory management and modular sharing of common data structures and computational services is

underway. Assembly of the complete databases to serve the entire continental U.S., development of specific scenarios for common classes of approved use patterns, and improvement of the models' internal algorithms, are ongoing activities of this project. A number of major revisions of codes and algorithms, most notably improvements in linkage of shallow groundwater and tile drains between PRZM and EXAMS and revision of exams' handling of sediment transport, benthic boundary layer exchanges, and sorption kinetics are in the design phase.

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